Case Report

Anodal Capture May Prevent Cardiac Resynchronization Therapy from Working Effectively. A Case Report of Left Ventricular Lead Dislodgement

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A 78-year-old man was implanted with a cardiac resynchronization therapy defibrillator. One month later, chest X-ray and electrocardiography suggested left ventricular (LV) lead dislodgement. However, the LV lead pacing threshold obtained by a programmer was unchanged because anodal capture had developed, which made it difficult to confirm the LV lead dislodgement. Radiographs obtained in the catheterization laboratory revealed that the tip of the LV lead had dislodged into the right atrium. The LV lead was relocated into another lateral coronary vein. Electrocardiography showed the QRS duration to be shorter than prior to this revision.
(J Arrhythmia 2011; 27: 150–153)

Key words: CRT, Anodal pacing, Lead dislocation, LV pacing, Biventricular pacing

Case Report

A 78-year-old man had been receiving medical treatment due to dilated cardiomyopathy for 21 years. His exercise tolerance decreased and New York Heart Association classification of cardiac performance worsened from grade II to grade III. Thus, in February 2008, he was hospitalized due to acute worsening of chronic heart failure. Electrocardiography exhibited a complete left bundle branch block (CLBBB) pattern and long QRS duration (PQ duration: 254 msec; QRS duration: 200 msec, **Figure 1A**). Echocardiographic findings revealed ventricular dilatation (LV end-diastolic/end-systolic diameter 88/80 mm) and global LV wall motion abnormality (ejection fraction 17%). He was implanted with a cardiac resynchronization therapy defibrillator (CRT-D) device (generator: Atlas + HF V-340; LV lead: 1056 K-75 cm (QuickSite); right ventricular (RV) lead: 7020-65 cm (Riata ST Optim); right atrial (RA) lead: 1688 T-52 cm (Tendril SDX), St. Jude Medical, St. Paul, MN, USA) (**Figures 2A** and **3A**). The LV lead was located in a postero-lateral coronary vein. LV pacing configuration was set so that a ring electrode of the RV lead was the anode electrode and a tip electrode of the LV lead was the cathode. CRT pacing settings were as follows: AV delay was 170 msec, PV delay was 150 msec, and VV delay was 0 msec. The patient was discharged with a

Received 14, September, 2010: accepted 10, February, 2011.
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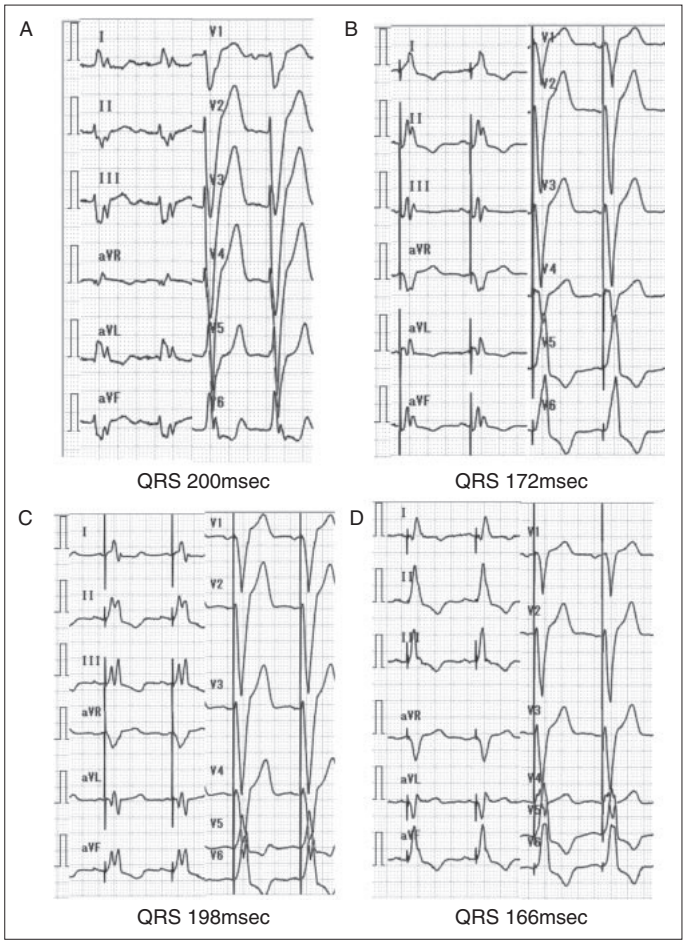

Figure 1 Electrocardiograms recorded pre CRT-D implantation (**A**), immediately after CRT-D implantation (**B**), one month after implantation (**C**), and after LV lead relocation (**D**).

favorable postoperative course one week after implantation. An electrocardiogram, chest X-ray, and the pacing threshold were the same as those immediately after implantation. At the CRT-D clinic visit one month after implantation, chest X-ray showed that the tip of the LV lead could not be found at the same spot as immediately after implantation (**Figure 2B**). On electrocardiograms, the QRS duration had increased from 172 msec immediately after implantation to 198 msec one month later (**Figures 1B** and **1C**). However, the pacing threshold of the LV lead was unchanged (1.5 V at 0.6 msec pulse width) while lead impedance was minimally changed from 740 ohms immediately after implantation to 530 ohms one month later. The patient's subjective symptoms did not change after CRT-D implantation. He was hospitalized for assessment of the implanted leads. Radiographs obtained in the catheterization laboratory revealed that the tip of the LV lead had dislodged into the RA and that the flexure of the RA lead was smaller one month after implantation (**Figure 3B**). In the device pocket, the anchoring sleeves of the LV and RA leads had loosened and these leads had thus been pulled into the pocket, which caused LV lead dislodgement. The LV lead was relocated into another lateral coronary vein and the anchoring sleeves were re-fixed. Electrocardiography showed the QRS duration to be shorter (166 msec, **Figure 1D**) than prior to this revision (198 msec, **Figure 1C**). He was discharged with a favorable postoperative course.

Discussion

In general, pacing lead dislodgement occurs shortly after implantation.[1)] In this case, the LV lead became dislodged within one month of the implantation procedure. However, the LV pacing threshold obtained by a programmer showed minimal change and was actually within normal range. Though an electrocardiogram and chest X-ray suggested the LV lead dislodgement, anodal capture made it difficult to confirm that by a programmer.

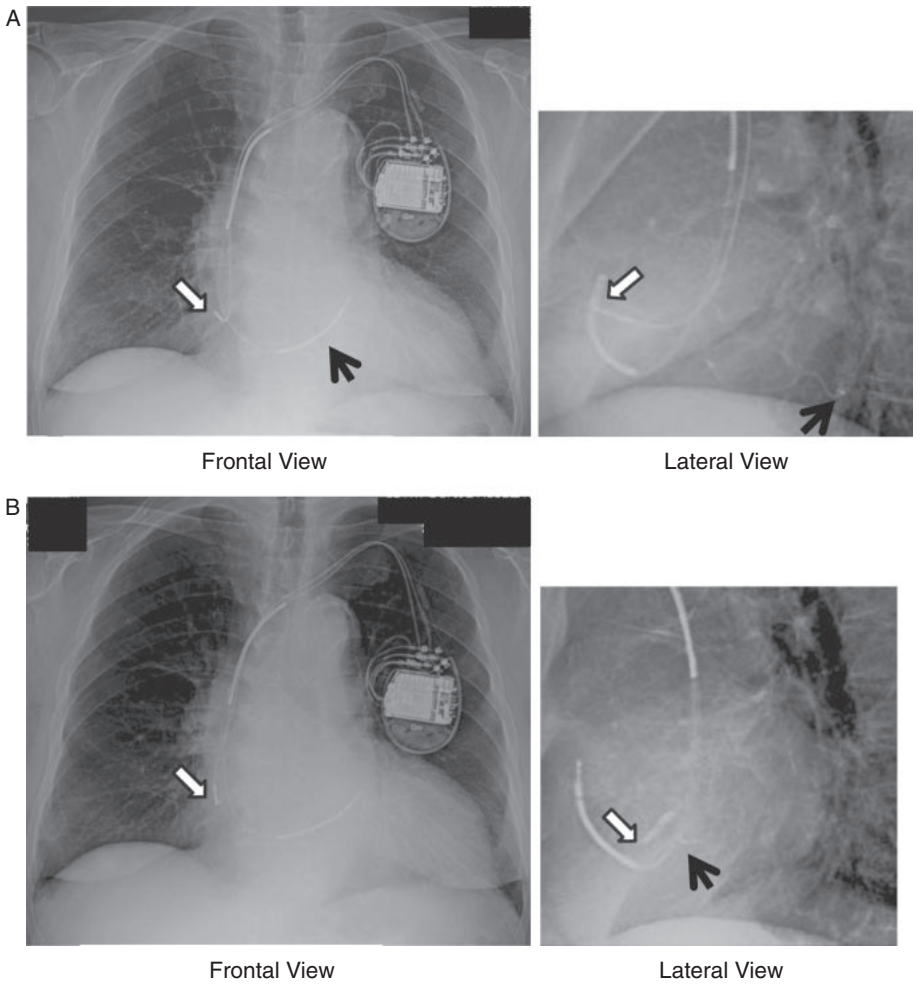

Figure 2 Chest X-rays taken immediately after implantation of a CRT-D (**A**) and one month later (**B**).
The frontal view is on the left, lateral view on the right. The tip of the left ventricular lead was located at the lateral wall immediately after implantation but was no longer in the same spot one month later (filled arrow). Flexure of the right atrial lead was smaller one month after implantation (open arrow).

Regarding anodal capture, Dekker demonstrated that the myocardium could be excited by anodal stimulation.[2] With a traditional pacemaker, anodal capture is not a critical issue because both an anodal electrode and a cathodal electrode exist in the right ventricle. However, in cardiac resynchronization therapy, anodal capture carries the risk that cardiac resynchronization therapy will not function effectively.[3–6] We must be cautious not to exacerbate cardiac dysfunction. Anodal capture reportedly occurs often when a true bipolar lead is used for the RV lead and a ring electrode of the RV lead is set as an anodal electrode.[6] In this case, the setting for LV lead stimulation was achieved in the same way. In using a true bipolar lead, we should avoid the ring electrode of the RV lead being set as an anodal electrode for LV lead stimulation. To avoid or correct anodal capture, we should consider using a bipolar LV lead, using a pacing vector that avoids the RV ring (unipolar LV to RV coil or to can), or adjusting the pacing output high enough to capture the LV and low enough not to capture the anodal RV.

There are some possibilities to explain the predominant CLBBB morphology on the electrocardiogram even after CRT in this case. Firstly, due to severe LV dilatation, CRT could not bring out desired reformation of ECG morphology. Secondly, there was no capture from the LV lead and the slight differences between the RV lead tip only and the RV tip + anodal RV caused the differences of QRS duration and morphology. Thirdly, there was LV tip capture but the RV anodal capture combined with RV tip resulted in a predominant CLBBB pattern. We should compare

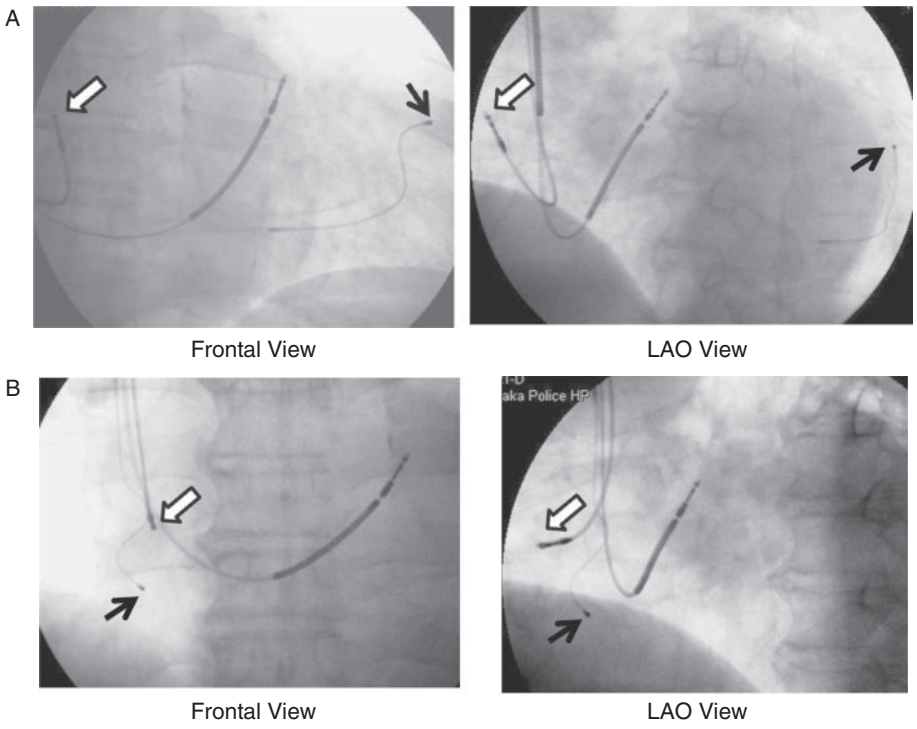

Figure 3 Radiographs obtained in the catheterization laboratory immediately after CRT-D implantation (**A**) and at re-hospitalization (**B**).
The frontal view is on the left, the left anterior oblique view on the right. The tip of the left ventricular lead was located at the lateral wall immediately after implantation but has been dislodged to the right atrium by the time of re-hospitalization (filled arrow). Flexure of the right atrial lead was smaller one month after implantation (open arrow).
LAO view: left anterior oblique view

ECG morphology in pacing the RV lead only, the LV lead only and the bi-ventricular leads.

At follow-up clinical examinations after the implantation of CRT, we should also assess the possibility of anodal RV capture. We should check not only the pacing parameters but also electrocardiographic morphology in pacing the RV lead only, the LV lead only and the bi-ventricular leads. If anodal RV capture emerges in pacing the LV lead, CRT does not work effectively. Furthermore, even if several parameters for CRT, such as VV delay, AV delay, and so on, are optimized, the desirable effect of CRT cannot be obtained when the anodal RV capture combines with the LV tip capture.

Recently, remote monitoring of devices has come into widespread use. It is both convenient and useful. However, as in this case, there is a risk that lead dislodgement is overlooked unless data obtained by a programmer is unchanged. Chest X-rays and electrocardiograms should be recorded regularly, especially immediately after implantation. In this case, the lateral view chest X-ray was more helpful for detecting LV lead dislodgement than the frontal view. Thus, we recommend that chest X-rays be taken from two angles.

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